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(54) Title: A MINERAL FIBER COMPOSITION

(57) Abstract

A biodegradable mineral fiber composition, characterized by the following constituents in percent by weight: SiO_2: 45 to 55; Al_2O_3: 0 to less than 4; Fe_2O_3: more than 7 to 15; CaO: 18 to 35; MgO: 5 to 15; Na_2O+K_2O: 0 to 10; P_2O_5: 0 to 5; impurities: 0 to 2.

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A mineral fiber composition

This invention relates to a mineral fiber composition which is biodegradable, i.e. the fibers decompose as soon as they come in contact with a physiological milieu.

The prior art already describes some mineral fiber compositions which are said to be biodegradable.

Biodegradability of mineral fiber compositions is of great importance since various studies indicate that mineral fibers with very small diameters in the range of under 3 microns are suspected to be carcinogenic, while biodegradable mineral fibers with such dimensions show no carcinogenicity.

However, mineral fiber compositions must also have good workability by known methods for producing mineral wool with a small diameter, in particular the jet process or the external rotary process. This involves in particular a sufficient difference of e.g. 80° between the devitrification and processing temperatures.

The mechanical and thermal properties of mineral fibers, or the products made therefrom, are also of crucial importance. Mineral fibers are used for example for insulating purposes to a great extent. Sufficient temperature resistance of the mineral fibers is necessary in particular for use in the industrial sector.

The problem of the invention is to provide a novel mineral fiber composition which is distinguished by high biodegradability, has sufficient temperature resistance for application in the industrial sector, and can be fiberized well.

The invention is based on the finding that this problem can be solved by a mineral fiber composition which consists substantially of silicon dioxide and alkaline-earth oxides,

and further contains alkali oxides as a melting accelerator and a considerable proportion of iron oxide for increasing temperature resistance.

It has turned out that such mineral fiber compositions fulfill the combination of necessary properties, namely biodegradability, sufficient temperature resistance for insulated objects in industry, as well as good workability in the production of the mineral wool as such and the products. This simultaneously means that the upper devitrification temperature of the melt is preferably under 1300°C.

The subject of the invention is a mineral fiber composition which is biodegradable, characterized by the following constituents in percent by weight:

SiO_2	45 to 55
Al_2O_3	0 to less than 4
Fe_2O_3	more than 7 to 15
CaO	18 to 35
MgO	5 to 15
$Na_2O + K_2O$	0 to 10
P_2O_5	0 to 5
Impurities	0 to 2

The inventive mineral fiber compositions are readily drawable in particular by the jet process, i.e. one obtains a mineral wool with a low-shot content.

The mineral fibers reach a high temperature resistance of at least 1000°C according to DIN 4102, part 17.

Such mineral fibers show good biodegradability.

The mean fiber diameter is usually 1 to 15 microns, a range of 2.5 to 8 microns being preferred.

The addition of alkali oxides causes a melting point reduction and therefore better workability in the melting process. Furthermore, up to 30% recycled glass can be used advantageously with a sodium-containing mineral wool composition.

The inventive mineral fiber compositions can preferably be melted in melting chambers fueled with fossile fuels, in particular natural gas, at melting temperatures from 1350 to 1450°C. Such melting chambers can produce a homogeneous melt, which is a prerequisite for constant product quality. Homogeneity of the glass melt also facilitates the reproducibility of the fiberizing process and thus of the thermal and mechanical product properties. Furthermore, the constant chemical composition of the thus produced mineral wool leads to controllable biodegradability.

In particular the addition of iron oxide increases the temperature resistance of the mineral wool.

The inventive mineral fiber compositions preferably have the following constituents in percent by weight:

SiO_2	45 to 53
Al_2O_3	0.3 to 3.9
Fe_2O_3	more than 7 to 13
CaO	20 to 25
MgO	10 to 15
$Na_2O + K_2O$	3 to 8
Impurities	0 to 2

A content of silicon oxide in the range of 46 to 52% by weight is especially preferred.

With respect to the alkali oxides a range of 3 to 6% by weight is especially preferred. Iron oxide is preferably present in a range between 7,1 and 11% by weight.

To assess biological degradability the standard powder test of the German Glass Society was used. This is an easily conducted method and gives a sufficient measure of biological degradability when used with a simulated physiological lung fluid at 37°C. The method is described in L. Springer, "Laboratoriumsbuch für die Glasindustrie", 3rd edition, 1950, Halle/S: W. Knapp Verlag.

The thermal behavior of the mineral fibers was determined by the so-called "Swedish method". This method uses a silit pipe furnace with a horizontal working pipe open on both sides with a length of 350 mm and an inside diameter of 27 mm. In the center of the furnace there is a ceramic supporting plate with dimensions of 30 x 20 x 3 mm for positioning the test sample. The test sample has dimensions of 12 x 12 x 12 mm or 12 mm ø x 12 mm height. The gross density is normally 100 kg/m^3. The temperature increase is 5 K/min. The change in test sample height is determined continuously with a reading optic.

The invention will be described more closely in the following using examples.

Example 1

A mineral wool was produced with the following composition in percent by weight:

SiO_2	47.4
Al_2O_3	0.6

Fe_2O_3	10.1
CaO	23.5
MgO	10.4
Na_2O	7.4
K_2O	0.3
Diverse	0.3

This composition could be readily fiberized by the jet process at a drawing temperature between 1300 and 1400°C into mineral fibers with a diameter range of 1.0 to 15 microns, a mean diameter range of 2.5 to 8.0 microns being preferred.

An investigation by the modified powder test of the Deutsche Glasgesellschaft yielded a value of 45 mg/kg and thus a value for high biodegradability.

Determination of thermal behavior by the "Swedish method" yielded a temperature resistance of 950°C with 20% height reduction, which can be clearly seen in the corresponding diagram shown by way of example in the single drawing.

Example 2

A mineral wool was produced with the following composition in percent by weight:

SiO_2	49
Al_2O_3	0.3
Fe_2O_3	10.0
CaO	23.5
MgO	12

Na_2O	5.5
Diverse	0.2

This composition could be readily fiberized by the jet process at a drawing temperature between 1300 and 1400°C into mineral fibers with a mean diameter range of 2.5 to 8.0 microns.

An investigation by the modified powder test of the Deutsche Glasgesellschaft yielded a value of 42 mg/kg and thus a value for high biodegradability.

Determination of thermal behavior by the "Swedish method" yielded a temperature resistance of 1000°C with 20% height reduction.

Example 3

A mineral wool was produced with the following composition in percent by weight:

SiO_2	48.7
Al_2O_3	0.5
Fe_2O_3	10.0
CaO	23.1
MgO	11.9
Na_2O	5.4
K_2O	0.1
Diverse	0.3

This composition could be readily fiberized by the jet process at a drawing temperature between 1300 and 1400°C into

mineral fibers with a diameter range of 1.0 to 15 microns, a mean diameter range of 2.5 to 8.0 microns being preferred.

Example 4

A mineral wool was produced with the following composition in percent by weight:

SiO_2	49.7
Al_2O_3	0.5
Fe_2O_3	9.0
CaO	23.1
MgO	11.9
Na_2O	5.4
K_2O	0.1
Diverse	0.3

This composition could be readily fiberized by the jet process at a drawing temperature between 1300 and 1400°C into mineral fibers with a diameter range of 1.0 to 15 microns, a mean diameter range of 2.5 to 8.0 microns being preferred.

Example 5

A mineral wool was produced with the following composition in percent by weight:

SiO_2	50.7
Al_2O_3	0.5

Fe_2O_3	8.0
CaO	23.1
MgO	11.9
Na_2O	5.4
K_2O	0.1
Diverse	0.3

This composition could be readily fiberized by the jet process at a drawing temperature between 1300 and 1400°C into mineral fibers with a diameter range of 1.0 to 15 microns, a mean diameter range of 2.5 to 8.0 microns being preferred.

Example 6

A mineral wool was produced with the following composition in percent by weight:

SiO_2	51.7
Al_2O_3	0.5
Fe_2O_3	7.1
CaO	23.1
MgO	11.9
Na_2O	5.4
K_2O	0.1
Diverse	0.2

This composition could be readily fiberized by the jet process at a drawing temperature between 1300 and 1400°C into mineral fibers with a diameter range of 1.0 to 15 microns, a mean diameter range of 2.5 to 8.0 microns being preferred.

Example 7

A mineral wool was produced with the following composition in percent by weight:

SiO_2	51.7
Al_2O_3	0.5
Fe_2O_3	7.1
CaO	25.5
MgO	11.9
Na_2O	3.0
K_2O	0.1
Diverse	0.2

This composition could be readily fiberized by the jet process at a drawing temperature between 1300 and 1400°C into mineral fibers with a diameter range of 1.0 to 15 microns, a mean diameter range of 2.5 to 8.0 microns being preferred.

Example 8

A mineral wool was produced with the following composition in percent by weight:

SiO_2	46.0
Al_2O_3	2.5
Fe_2O_3	7.1
CaO	27.5
MgO	13.3

Na_2O	3.0
K_2O	0.1
Diverse	0.5

This composition could be readily fiberized by the jet process at a drawing temperature between 1300 and 1400°C into mineral fibers with a diameter range of 1.0 to 15 microns, a mean diameter range of 2.5 to 8.0 microns being preferred.

Claims

1. A mineral fiber composition which is biodegradable, characterized by the following constituents in percent by weight:

SiO_2	45 to 55
Al_2O_3	0 to less than 4
Fe_2O_3	more than 7 to 15
CaO	18 to 35
MgO	5 to 15
$Na_2O + K_2O$	0 to 10
P_2O_5	0 to 5
Impurities	0 to 2

2. The mineral fiber composition of claim 1, characterized by the following constituents in percent by weight:

SiO_2	45 to 53
Al_2O_3	0.3 to 3.9
Fe_2O_3	more than 7 to 13
CaO	20 to 25
MgO	10 to 15
$Na_2O + K_2O$	3 to 8
Impurities	0 to 2

3. The mineral fiber composition of claim 1 or 2, characterized in that the proportion of silicon dioxide is 46 to 52% by weight.

4. The mineral fiber composition of any of claims 1 to 3, characterized in that the alkali oxides are present in a quantity of 3 to 6% by weight.

5. The mineral fiber composition of any of claims 1 to 4, characterized in that iron oxide is present in a content between 7 and 11% by weight.

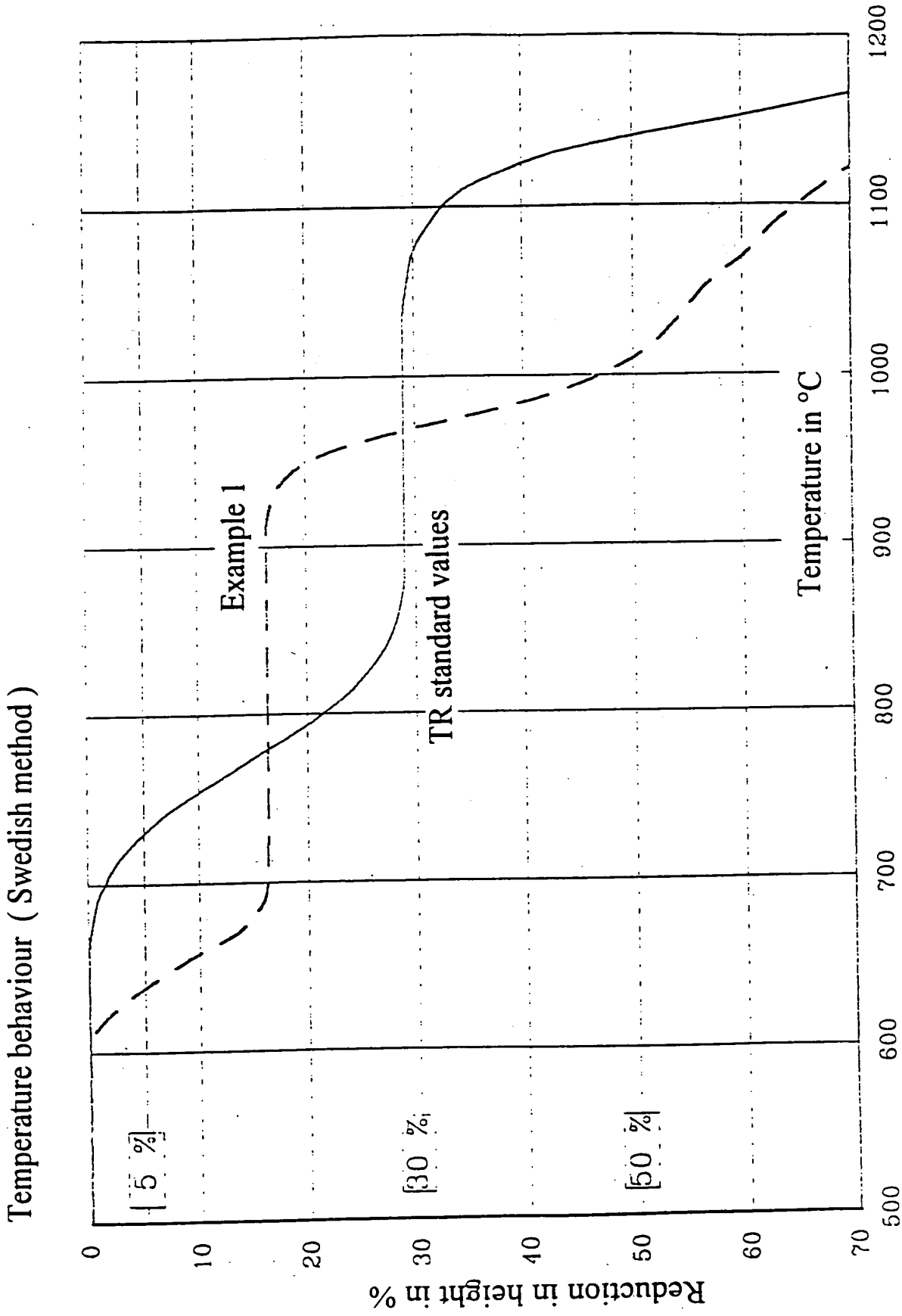
Temperature behaviour (Swedish method)
Reduction in height in %
0
10
20
30
40
50
60
70
500
600
700
800
900
1000
1100
1200
Temperature in °C
Example 1
TR standard values
5 %
30 %
50 %

Fig. 1

INTERNATIONAL SEARCH REPORT

Inter: ional Application No
PCT/EP 95/04730

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 C03C13/06 C03C13/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 C03C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO,A,93 22251 (ISOVER SAINT-GOBAIN) 11 November 1993 see page 1, line 37 - page 4, line 3; examples 12,13; tables 1,4	1-5
X	WO,A,94 14717 (ROCKWOOL INTERNATIONAL A/S) 7 July 1994 see page 3, line 3 - line 20; table 1	1,5
A		2-4

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☒ Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter nal Application No
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
WO-A-9322251	11-11-93	FR-A-	2690438	29-10-93
		AU-B-	4263293	29-11-93
		BR-A-	9305492	11-10-94
		CA-A-	2110998	11-11-93
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		CZ-A-	9302865	19-10-94
		EP-A-	0596088	11-05-94
		HU-A-	67212	28-03-95
		JP-T-	6508600	29-09-94
		NO-A-	934725	20-12-93
		SI-A-	9300218	31-12-93
		SK-A-	146893	09-11-94
		ZA-A-	9302874	01-06-94
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		CA-A-	2152920	07-07-94
		EP-A-	0677026	18-10-95
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